

CLAIMS

1. Method of determining the velocity  $V$  and anellipticity  $\eta$  parameters for processing seismic traces in a common midpoint (CMP) gather including an anelliptic NMO correction, comprising:

- 5       - a preliminary step to define a plurality of nodes  $(dtn, \tau_0)$ , the said nodes being indicative of parameters  $dtn$  and  $\tau_0$  representing the NMO correction for the maximum offset and the zero offset travel time in hyperbolic coordinates, the said preliminary step being
  - 10 followed by
    - for each node  $(dtn, \tau_0)$  defined in the preliminary step, the following steps:
      - for static NMO correction of traces in the CMP gather as a function of the values of the said parameters
      - 15  $dtn$  and  $\tau_0$  at the node considered, and
        - for calculating the semblance function associated with the said NMO correction for the node considered; and
        - for each picked time  $t_0$ , a step including
        - 20 determination of the maximum semblance node  $(dtn(t_0), \tau_0(t_0))$ ,
        - and a final step to convert the  $dtn(t_0)$  and  $\tau_0(t_0)$  parameters so as to obtain the velocity  $V(t_0)$  and anellepticity  $\eta(t_0)$  laws.

25       2. Method according to claim 1, wherein the nodes are defined during the preliminary step in an analysis volume  $(dtn, \tau_0, t_0)$  determined by minimum and maximum values respectively  $[dtn_{min}, dtn_{max}]$   $[\tau_{0min}, \tau_{0max}]$  and  $[t_{0min}, t_{0max}]$  of the  $dtn$ ,  $\tau_0$  and  $t_0$  parameters.

3. Method according to claim 2, wherein, during the preliminary step, a corridor  $[dtn_{min}(t_0), dtn_{max}(t_0)]$ ,  $[\tau_{0min}(t_0), \tau_{0max}(t_0)]$  for changing dtn and  $\tau_0$  parameters is delimited inside the analysis volume as a function of plausible velocity V and anellipticity  $\eta$  values, the nodes (dtn,  $\tau_0$ ) defined for applying the NMO correction being then located along the corridor thus delimited.

4. Method according to any one of the preceding claims, further comprising, for each node (dtn,  $\tau_0$ ), a stacking step of the corrected seismic traces, following the semblance function calculation step.

5. Method according to claim 4, wherein the stacking of corrected traces is done using only near offset traces.

6. Method according to any one of claims 4 or 5, further comprising for each picked time, and following the step for determining the maximum semblance node, a step of checking that values dtn and  $\tau_0$  of the maximum semblance node correspond to a stacking extreme value for the same values dtn and  $\tau_0$ .

7. Method according to any one of the preceding claims, further comprising a step of selecting and adjusting the pickings obtained, following the step implemented for determining the maximum semblance node (dtn( $t_0$ ),  $\tau_0(t_0)$ ) for each picked time  $t_0$ , before the conversion step.

8. Method according to claim 7, wherein the said step of selecting and adjusting the pickings comprises a step of only retaining pickings dtn and  $\tau_0$  for which time to the highest semblance pickings is greater than a predefined value.

9. Method according to claim 8, wherein the said step of selecting and adjusting the pickings also comprises a step for adjusting the retained pickings  $dt_n$  and  $\tau_0$  by parabolic interpolations using values about the said picked values.

10. Method according to claim 9, wherein the said step of selecting and adjusting pickings also comprises a step of eliminating retained and adjusted pickings  $dt_n$  and  $\tau_0$  when it is impossible to calculate the Dix interval velocities between the picking considered and higher semblance pickings.

11. Method according to any one of claims 1 to 10, wherein the processing applied to seismic traces is an NMO correction process implementing a static correction  $CORR_{NMO}$ .

12. Method according to claim 11, wherein, during the preliminary step, the NMO corrections  $CORR_{NMO}$  are calculated for all nodes ( $dt_n$ ,  $\tau_0$ ) included in the analysis volume and all offsets of processed seismic traces.

13. Method according to claim 12, wherein the NMO correction carried out for each node ( $dt_n$ ,  $\tau_0$ ) consists of applying NMO corrections  $CORR_{NMO}$  calculated during the preliminary step.

14. Method according to any one of claims 11 to 13, wherein for a given ( $dt_n$ ,  $\tau_0$ ) pair, the static NMO correction  $CORR_{NMO}$  of a seismic trace with offset  $x$  is carried out according to the following equation:

$$CORR_{NMO}(x) = -\tau_0 + \sqrt{\tau_0^2 + \frac{dt_n(dt_n + 2\tau_0)}{x_{max}^2} x^2} \quad \text{in which } x_{max}$$

represents the maximum Offset in the CMP gather.

15. Method according to any one of claims 1 to 10, wherein the processing applied to seismic traces is a PSTM migration using a static NMO correction  $CORR_{PSTM}$ .

16. Method according to claim 15, wherein, during  
5 the preliminary step, the NMO corrections  $CORR_{PSTM}$  are calculated for all nodes (dtn and  $\tau_0$ ) included in the analysis volume and all migration offsets inside the migration aperture.

17. Method according to claim 16, wherein the NMO  
10 correction step carried out for each node (dtn and  $\tau_0$ ) comprises, for each offset class, application of the said NMO corrections  $CORR_{PSTM}$ , calculated during the preliminary step on all midpoints inside the migration aperture.

18. Method according to claim 17, wherein the NMO  
15 correction step carried out for each node (dtn and  $\tau_0$ ) comprises, for each offset class, the stack of the corrected midpoints following application of the said NMO corrections  $CORR_{PSTM}$ .

19. Method according to any one of claims 15 to 18,  
20 wherein, for a given pair (dtn and  $\tau_0$ ), the static NMO correction  $CORR_{PSTM}$  is carried out according to the following equation:

$$Corr_{PSTM}(x) = -\tau_0 + \sqrt{\frac{\tau_0^2}{4} + \frac{dtn(dtn+2\tau_0)(x-x+h)^2}{x_{max}^2}} + \sqrt{\frac{\tau_0^2}{4} + \frac{dtn(dtn+2\tau_0)(x-x-h)^2}{x_{max}^2}}$$

25 where:

- $x_m$  represents the coordinates of the midpoints,
- $x - x_m$  represents the migration aperture PSTM,
- $h$  is the half source - receiver offset,
- $x_{max}$  is the maximum offset and aperture of the  
30 migration.

20. Method according to any one of claims 14 or 19, wherein, during the final conversion step, the parameters dtn (t0) and (τ0) are converted to the velocity law V(t0) according to the following equation:

$$V = \frac{x_{\max}}{\sqrt{dtn(dtn + 2\tau_0) \frac{t_0}{\tau_0}}}$$

21. Method according to one of claims 14 or 19, wherein, during the final conversion step, the parameter τ0 (t0) is converted to the anellepticity η(t0) law

$$\text{according to } \eta = \frac{1}{8} \left( \frac{t_0}{\tau_0} - 1 \right)$$

22. Method according to claims 20 and 21; wherein parameter dtn is defined with respect to the velocity V and anellepticity η according to the following equation:

$$dtn = \frac{8\eta}{1+8\eta} t_0 + \sqrt{\left( \frac{t_0}{1+8\eta} \right)^2 + \frac{x_{\max}^2}{(1+8\eta)V^2}}$$

23. Method according to claim 21, wherein parameter τ0 is defined according to anellepticity η according to the following equation:

$$\tau_0 = \frac{t_0}{1+8\eta}$$

24. Method of characterising a velocity field for processing seismic data using a gather of seismic traces at common midpoint, wherein, for each travel time t0 for a zero offset, a set of parameters dtn and τ0 is defined, representing the NMO correction for maximum offset, and the zero offset travel time respectively, in hyperbolic coordinates.